Available online at www.sciencedirect.com

ScienceDirect

International Journal of Project Management 32 (2014) 1019–1041

International Journal of Project Management

www.elsevier.com/locate/ijproman

EDM: Earned Duration Management, a new approach to schedule performance management and measurement

Homayoun Khamooshi *, Hamed Golafshani [1]

Department of Decision Sciences, School of Business, The George Washington University, Washington, D.C. 20052, United States

Received 2 February 2013; received in revised form 3 October 2013; accepted 12 November 2013
Available online 19 December 2013

Abstract

The concept of schedule monitoring and control as one of the most important functions of project and program management has not been fully exploited. One possible explanation could be the dominance of the Earned Value Management System (EVMS, also known as EVM). EVM was originally developed as a cost management and control tool which was extended to track the schedule as well. EVM and its derivatives (e.g. Earned Schedule) use cost as a proxy to measure schedule performance to control the duration of the project. While there is a correlation between schedule, cost, quality, and scope of a project, using cost to control duration has proven to be misleading. In contrast to Earned Value and Earned Schedule, the authors have developed the Earned Duration Management (EDM) in which they have decoupled schedule and cost performance measures and developed a number of indices to measure progress and performance of schedule and cost, as well as the efficacy and efficiency of the plan at any level of the project. These new indices are easy to understand, have wider applications, and can be used by contractors, clients and the scheduling offices to assess and measure schedule performance. The newly developed duration performance measures are all schedule-based and can be used for forecasting the finish date of the project.

Keywords: Earned Value; EVM; Earned Schedule; Earned Duration; Earned Duration Management; EDM; Schedule management; Monitoring and control; Efficiency; Performance measurement; Forecasting; Estimation index; Performance and progress index; Project management

1. Introduction

Project management is about being in control, making sure that the risk of failure is minimized by keeping the project in alignment with the developed project plan. It is also about making informed decisions for adjustments to the plan when required.

Project monitoring and control, on the other hand, is the process of observing the implementation of the project plan, collecting data on implementation, conducting analysis by comparing the planned values against the actual implementation records, and using this information to keep the project on track. One of the most widely accepted control systems used by practitioners in project management field is referred to as the Earned Value Analysis (EVA) or Earned Value Management System (EVMS) or in short EVM.

The evolution of EVM, for the most part, has been focused on cost management, control, and financial analysis for decades (Brandon, 1998; Fleming and Koppelman, 2004; Kim et al., 2003). This analysis mechanism was developed based on a set of 35 criteria, called the Cost/Schedule Control Systems Criteria (C/SCSC). Later the C/SCSC method was modified to accommodate ease of use and pragmatism simply because the original version was too bureaucratic and complicated. Also, the organizations were reluctant to spend a lot of time and money on setup costs for its implementation (GAO, Significant Changes Underway in DOD's Earned Value Management Process, 1997). The U.S. government and the associated agencies opted for making the use of EVM a requirement of government contracting

* Corresponding author at: Department of Decision Sciences, Funger Hall, Suite 415, The George Washington University, Washington, D.C. 20052, United States. Tel.: +1 202 994 4862; fax: +1 202 994 2736.
E-mail addresses: hkh@gwu.edu (H. Khamooshi), gol@gwmail.gwu.edu (H. Golafshani).
[1] Federal Aviation Administration.

0263-7863/$36.00
http://dx.doi.org/10.1016/j.ijproman.2013.11.002

and bidding for projects (General Service Administration, Department of Defense, and National Aeronautics And Space Administration, 2006). There is abundance of literature on EVM and its basic principles and definitions (e.g. see Anbari, 2003; Fleming and Koppelman, 2010).

In short, a clear project scope, a well-defined schedule, and detailed budget lay the foundation for implementing EVM and its derivatives for a project. The budget plan and schedule are to be set for the lowest level of Work Breakdown Structure (WBS) elements to be monitored and controlled. Such a plan will be considered a baseline for the project and the progress will be assessed against that baseline (Cioffi, 2006).

EVM defines parameters to enable monitoring and controlling of projects. EVM defines the Planned Value (*PV*) as the value that is planned to be spent for executing the work according to the original schedule at any point in time. Previously, *PV* was denoted as BCWS or Budgeted Cost of Work Scheduled. Earned Value (*EV*) is the monetary value of the progress made (work completed) at a certain point in time. Previously, *EV* was denoted as BCWP or Budgeted Cost of Work Performed. Actual Cost (*AC*) represents the monetary value of what has been expensed to achieve the progress made at a certain point in time. Previously, *AC* was denoted as ACWP or Actual Cost of Work Performed.

Prior to the dominance of EVM, *PV* and *AC* were mainly the determinant factors in measuring project progress. However, these measures were not enough for showing the entire picture and determining whether the project was getting the worth of what it was expending. EVM provides various performance measures that are designed to assist with monitoring and controlling the project depending on the type of information needed. For instance, Cost Variance (*CV*) is utilized to represent the difference between how much was actually spent and the value earned (*EV*) through the work performed. In that case, *CV* is defined as:

$$CV = EV - AC \tag{1}$$

Hence, a negative value points out that the project has spent more for the executed activities than what it is worth. To the contrary, a positive value indicates that the project has spent less to gain the value of the executed work. In general, EVM and its derivatives use positive values to represent favorable signs of progress and negative values as unfavorable signs. The Schedule Variance (*SV*) per EVM has traditionally been used as an indicator which represents whether the project is on schedule or not:

$$SV = EV - PV \tag{2}$$

Similar to *CV*, a negative *SV* means that the project is behind the planned schedule, whereas a positive *SV* represents a project that is ahead of schedule. It is to be noted that, this schedule performance measure is not very reliable when the cost of delayed critical activities is a fraction of the cost of other activities. Hence, the delay in completion of these critical activities does not present much of a variance! Additionally, when the activities finish, *SV* equals to zero as both *EV* and *PV* are the same upon completion of the activity. This outcome is irrespective of whether the actual duration of the activity happened before or after its planned completion date. There are other widely used performance measures that calculate project efficiency, or forecast a future state of the project, among other things. These include, Cost Performance Index:

$$CPI = \frac{EV}{AC} \tag{3}$$

and Schedule Performance Index:

$$SPI = \frac{EV}{PV} \tag{4}$$

Despite EVM's numerous benefits and its widespread use, there are some concerns with utilizing EVM as the only tool for monitoring and controlling cost and schedule of a project. Paige in a lucid paper some 50 years ago proposed the separation of concerns with schedule from concerns with budgetary matters (Paige, 1963). It was not till a few years ago where researchers and practitioners brought up the issues with use of EVM for schedule management. The cost management component of EVM is considered to be very effective whereas its schedule aspect has been questioned conceptually in the last few years. Fleming and Koppelman (Fleming and Koppelman, 2004) recommend that Schedule Performance Index should be used just as a warning mechanism and not as a real tool to analyze how the project is performing with regard to schedule.

Lipke argued (Lipke, 2003) that "from the time of the development of the EVM indicators, it has been known that the schedule indicators are flawed and exhibit strange behavior over the final third of the project when performance is poor". He introduced the concept of Earned Schedule, ES, as an extension to EVM. This research shows that *SPI* is not an accurate or reliable measure of schedule performance. The reason given is the fact that any finished activity has an *SPI* equal to one. This perfect score is irrespective of the actual performance of the completed activity. To improve the performance of *SPI*, the Earned Schedule method converts the Earned Value at a given point in time into its equivalent duration (on the *PV* or planned value graph) required to achieve that Planned Value. Fig. 1 demonstrates this conversion on a conceptual EVM graph.

Using this approach, the method provides the Earned Schedule, *ES*(*t*), for the project. Therefore, Earned Schedule could mathematically be defined as adapted from (Jacob, 2006) as:

$$\begin{aligned} &\text{Find t such that } EV \geq PV_t \text{ and } EV < PV_{t+1(calendar\ unit)} \\ &ES(t) = t + \frac{EV - PV_t}{PV_{t+1(calendar\ unit)} - PV_t} \times 1\ (calendar\ unit) \end{aligned} \tag{5}$$

where *ES*(*t*) is Earned Schedule at the status date, *EV* is the Earned Value at the status date, PV_t is the Planned Value at time instant t, and the calendar unit represents the unit in which duration t is measured. The corresponding duration from the beginning of the project till status date is generally defined as Actual Time (AT) or elapsed time. We use the term Actual Duration (*AD*) in place of Actual Time for consistency and accuracy in this paper.